Proposed
Total Maximum Daily Load Development
For the
Northern and Central Indian River Lagoon and Banana River Lagoon, Florida

Nutrients, Chlorophyll a and Dissolved Oxygen

June 30, 2003

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LIST OF ABBREVIATIONS

BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
SJRWMD	St. Johns River Water Management District
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET

Total Maximum Daily Load (TMDL) Development for the

North and Central Indian River Lagoon and Banana River Lagoon

- **303(d) Listed Waterbody Information**

State	Florida
County	Volusia, Brevard, Indian River, St. Lucie
Major River Basin	Indian River Lagoon
Watershed	3080202, 3080203
Constituent(s) Causing Impairments	Nutrients (TN, TP), Chlorophyll a, Dissolved Oxygen
Designated Uses	Class III

TMDL Development

- **Analysis/Modeling**:

St Johns River Water Management District's Pollutant Load Screening Model (PLSM) was used to assess watershed characteristics and develop estimates of nutrient loading from nonpoint sources to the North and Central Indian River Lagoon and Banana River Lagoon (N&CIRL& BRL). Existing information regarding wet weather discharges and nutrient concentrations were used to develop estimates for point source loading from permitted wastewater treatment plants. Estimates of historic loading rates were developed using PLSM to establish allowable nutrient loads that would be protective of the Class III designated use of Recreation, Propagation and Maintenance of a Healthy, Well-balanced Population of Fish and Wildlife.

Critical Conditions:

An average annual loading rate using a 25 year period of mean annual rainfall (1930-1954) was applied to develop annual average annual loads to the lagoon for Total Nitrogen and Total Phosphorus. Average annual loads were used because the critical resource is seagrass which grows year-round and is negatively affected by light attenuation caused by diminished water column clarity. In turn, water column clarity is affected in part by incoming nutrient loads which trigger the growth of phytoplankton and epiphytes that cause diminished water column clarity. Model results for average annual loads are consistent with observed data.

Seasonal Variation:

Seasonal variation is taken into account in this approach in that wastewater treatment plants only discharge during the wet season. Wet season nutrient loads were calculated based on measured flow and average nutrient concentrations in those discharges over a 4 year period (1996-1999).

Nutrient Allocations by Indian River Lagoon Segment (North, South and Banana River Lagoon)

Segment	LAs (lb per year)		WLAs (lb per year)		MOS (lb per year)	TMDL (lb per year)		Percent Reduction	
Parameter	TN	TP	TN	TP		TN	TP	TN	TP
IR 1-3	107925	18932	88364	9549	implicit	196289	28481	13.41	3.25
IR4	9356	2070			implicit	9356	2070	47.30	20.08
IR5	87470	9966			implicit	87470	9966	35.00	40.41
IR6-7	67735	12230	1560	73	implicit	69295	12303	36.51	29.38
IR8	13143	2860	25	27	implicit	13168	2887	40.09	7.23
IR9-11	64697	7652			implicit	64697	7652	58.80	66.10
IR12	439505	41135			implicit	439505	41135	15.28	40.79
IR13A	7899	846			implicit	7899	846	0.25	13.76
IR13B	65818	6734			implicit	65818	6734	-1.62	7.44
IR14	715898	73692			implicit	715898	73692	-2.90	35.78
IR15	16739	3092			implicit	16739	3092	14.37	11.07
IR16-20	312935	46314	28786	3448	implicit	341721	49762	37.71	47.81
IR21	5342	876			implicit	5342	876	60.82	56.61
BR1-2	81767	7995			implicit	81767	7995	36.12	49.89
BR3-5	20798	2380	14805	2849	implicit	35603	5229	56.87	58.27
BR6	10708	1697			implicit	10708	1697	77.49	74.70
BR7	10094	1147			implicit	10094	1147	76.95	81.82
3163	137389	23630	3774	320	implicit	141163	23950	36.87	44.11
Total	2175218	263248			implicit	2312532	279514		

- Public Notice Date: June 30, 2003
- Submittal Date:
- Establishment Date:
- Endangered Species (yes or blank): Yes
- EPA Lead on TMDL (EPA or blank): EPA
- TMDL Considers Point Source, Nonpoint Source, or Both: Both
- NPDES Discharges of Nutrients

NPDES No.	Facility Name	TN WLA (lbs)	TP WLA (lbs)
FL0020541	CAPE CANAVERAL (DW)	5873.70	427.40
FL0021105	COCOA BEACH, WRF	8930.53	2421.93
FL0021431	EDGEWATER, CITY OF (DW)	5330.10	733.35
FL0021521	COCOA/JERRY SELLERS (DW)	1559.71	73.08
FL0021571	ROCKLEDGE, CITY OF (DW)	24.84	27.34
FL0021661	VERO BEACH, CITY OF (DW)	28786.48	3447.89
FL0027278	FORT PIERCE UTILITY AUTHORITY--WWTF	3774.43	319.67
FL0042293	BAREFOOT BAY (DW)	---	---
FL0172090	NEW SMYRNA BEACH (DW)	83034.39	8816.16

1. Introduction

The Clean Water Act (CWA) [40 CFR Part 130] requires each State to identify waters within its boundaries not meeting water quality standards applicable to the water's designated uses. This list of identified waters (referred to as the 303(d) list) must be submitted to the U.S. Environmental Protection Agency (EPA) for review and approval. The "listed" waters identified by the State are prioritized for Total Maximum Daily Loads (TMDL) development based on factors described in CWA regulations, such as the use of the water and the severity of pollution. A separate TMDL is established for each pollutant at a level necessary to attain the applicable water quality standards taking into account seasonal variations and a margin of safety. The TMDL establishes allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. With this information, states can establish water-quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. Indian River Lagoon, a Group 5 Basin water body, was designated a "special water" and scheduled for TMDL development by June 30, 2003 in a 1999 Consent Decree (FL Wildlife Federation et. al. v. Carol Browner et. al., Case No. 98-35b-CIV-Stafford). The Indian River Lagoon is geographically located mostly within the St. Johns River Water Management District (SJRWMD) with the very south portion of the Lagoon located within the South Florida Water Management District (SFWMD).

2. Problem Definition

There are 17 segments of the Indian River Lagoon basin (Figure 1 & Table 1) that were identified on the Florida Department of Environmental Protection (DEP) 1998 303(d) list as impaired by nutrients, dissolved oxygen, or chlorophyll a and are scheduled for TMDL development by June 30, 2003. This schedule is mandated by a 1999 Consent Decree (Florida Wildlife Federation et. al. v. Carol Browner et. al., Case No. 98-356-CIV-Stafford). The pollutants for which TMDLs will be established are nutrients, chlorophyll, and dissolved oxygen. All of these segments fall within the FL DEP Indian River Lagoon Group 5 Basin and, as a result, are scheduled for TMDL development by FL DEP in September 2004. Since FL DEP's schedule for TMDL development is inconsistent with EPA's court-ordered schedule, EPA must develop TMDLs, where appropriate, for the pollutants of concern for these segments.

Table 1 Impaired WBIDs within the IRL N&C & BRL Watershed

WBID Name	WBID	Basin	Body	Parameters for TMDL
EAU GALLIE RIVER	3082	Indian River Lagoon	ESTUARY	Nutrients, Chla
CRANE CREEK	3085	Indian River Lagoon	STREAM	Nutrients, Chla
TURKEY CREEK	3098	Indian River Lagoon	ESTUARY	Chla, DO
NO. PRONG SEBASTION R	3128	Indian River Lagoon	STREAM	Nutrients, Chla, DO
C-54 CANAL	3135	Indian River Lagoon	ESTUARY	Nutrients, Chla, DO
FELSMERE CANAL	3136	Indian River Lagoon	STREAM	Nutrients, Chla, DO
INDIAN R. AB SEB INLET	2963A	Indian River Lagoon	ESTUARY	Nutrients
INDIAN R. AB MELB CSWY	2963B	Indian River Lagoon	ESTUARY	Nutrients, DO
INDIAN R. AB MELB CSWY	2963C	Indian River Lagoon	ESTUARY	Nutrients
INDIAN R. AB 520 CSWY	2963D	Indian River Lagoon	ESTUARY	Nutrients, DO
BANANA R. BL MATHERS	3057A	Indian River Lagoon	ESTUARY	Nutrients, DO
BANANA R. AB 520 CSWY	3057B	Indian River Lagoon	ESTUARY	Nutrients, DO
CRANE CREEK	3085A	Indian River Lagoon	ESTUARY	Nutrients, Chla
SEBASTION R. AB IND R.	3129A	Indian River Lagoon	ESTUARY	Nutrients, Chla, DO
SOUTH INDIAN RIVER	5003C	Indian River Lagoon	ESTUARY	Nutrients, Chla, DO
SOUTH INDIAN RIVER	5003D	Indian River Lagoon	ESTUARY	Nutrients, Chla, DO
BELCHER CAN/TAYLOR CK	3163	St.Lucie - Loxahatchee	STREAM	Nutrients, Chla, DO

The TMDLs addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). These conditions include a requirement that TMDLs be proposed for Indian River Lagoon by June 30, 2003, for each water on the 1998 303(d) list that is designated as not meeting water quality standards.

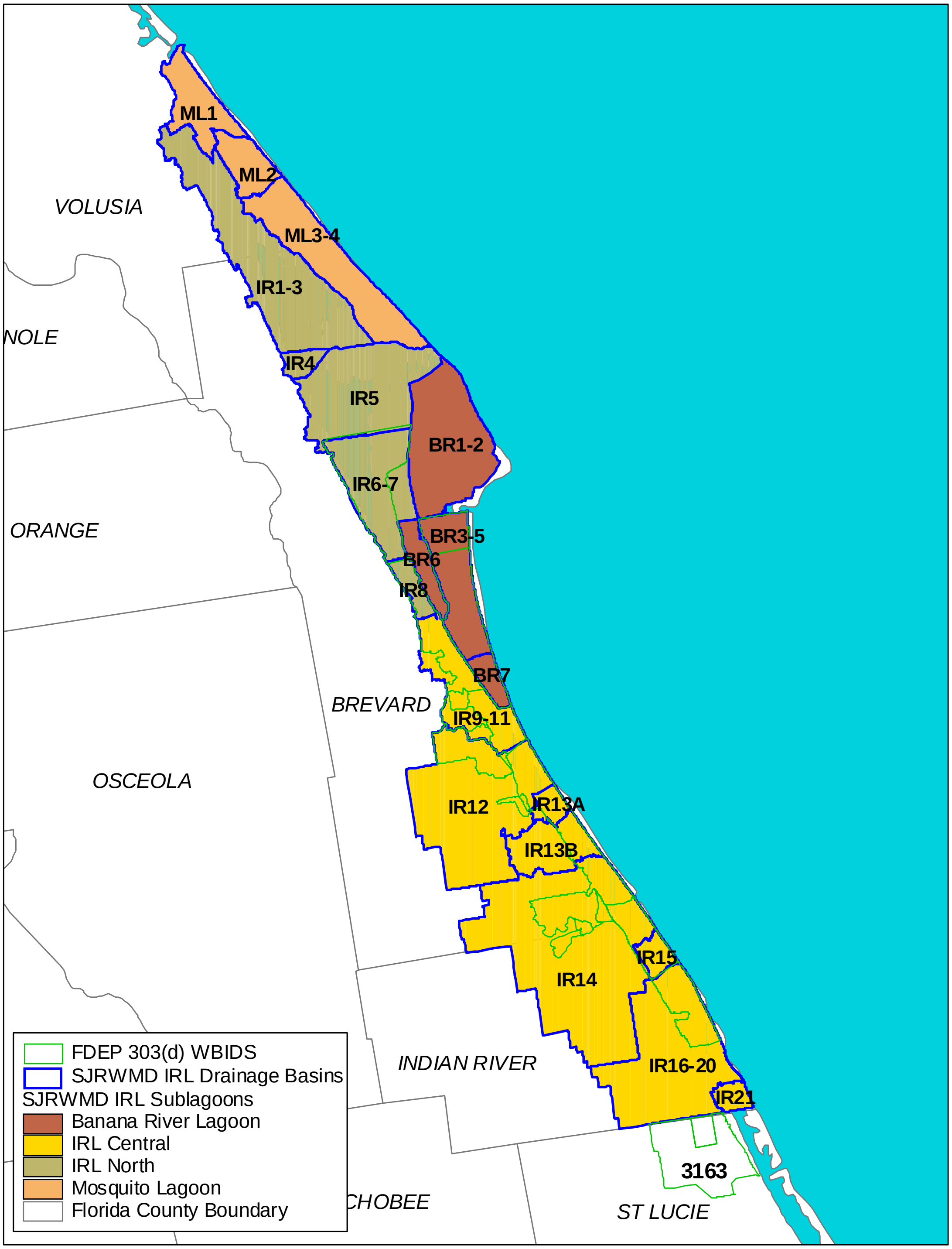

Figure 1 Impaired WBIDs within the IRL N&C & BRL Watershed

3. Watershed Description

The Indian River Lagoon runs along the central portion of the Atlantic coastline of Florida for a distance of 155 miles from the Ponce De Leon Inlet southward to Jupiter

Inlet and includes portions of Volusia, Brevard, Indian River, St. Lucie, Martin and Palm Beach Counties. The watershed consists of three major inter-connected lagoons commonly referred to as Mosquito Lagoon, Indian River Lagoon and Banana River Lagoon. The lagoon system and contributing watershed currently covers an area of approximately 2,284 square miles, almost twice the size of the original watershed of approximately 1,150 square miles. The lagoon has an average depth of 4 feet and the width varies from 0.5 to 5.5 miles. Average annual rainfall within the watershed is approximately 50.2 inches and average annual evapotranspiration is almost 49 inches. Tributary streams to the Indian River Lagoon are relatively short in length. Some of the western edge of the watershed is bounded by the St. Johns River which runs south to north and discharges to the Atlantic Ocean east of Jacksonville.

Circulation within the lagoon is influenced by winds, freshwater inflows from tributaries, and tidal exchange via direct connections to the Atlantic Ocean. In general, the Mosquito Lagoon and Banana River Lagoon are characterized by low freshwater inflows and poor flushing with little or no direct connection to the Atlantic Ocean. The Indian River Lagoon portion has four connections to the Atlantic via Sebastian Inlet, Fort Pierce Inlet, St. Lucie Inlet and Jupiter Inlet. Freshwater inflows come from direct overland runoff, streams, drainage canals, groundwater seepage and limited wet season discharges from a few wastewater treatment facilities.

The Indian River Lagoon is a nationally renowned aquatic ecosystem that supports tremendous biodiversity and provides recreational and commercial fishing resources as well. The Indian River Lagoon has received the attention of the State of Florida Department of Environmental Protection, the St. Johns River Water Management District and South Florida Water Management District, and the National Estuary Program. Tremendous efforts are underway by these agencies and programs to document the resources, identify historic and current environmental conditions and develop plans to restore and maintain these valuable natural resources. The most recent comprehensive report summarizing these efforts is the Indian River Lagoon Surface Water Improvement and Management Plan 2002 Update (SFWMD and SJRWMD, 2002).

4. Water Quality Standards

The waterbodies within the Indian River Lagoon watershed are Class III Freshwater or Marine with a designated use of Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife (FAC 62-302.400 (1)). The water quality standards in violation that led to the original listing are as follows:

4.1. Narrative Nutrients:

"In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." (FAC 62.302.530 (48)(b))

4.2. Dissolved Oxygen (Class III Fresh):

"Shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained." (FAC 62-302.530 (31))

4.3. Dissolved Oxygen (Class III Marine):

"Shall not average less than 5.0 mg/L in a 24 hour period and shall never be less than 4.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained." (FAC 62-302.530 (31))

In addition, several WBIDs were listed for impairments by chlorophyll a. While there is no water quality standard specifically for chlorophyll a, elevated levels of chlorophyll a can be associated with a violation of the narrative nutrient standard.

5. Linkage of Water Quality Standards to the Critical Resource

The draft Indian River Lagoon Surface Water Improvement Management Plan (SWIM) update provides a more thorough analysis and representation of the significant water quality issues confronting the Indian River Lagoon. Two of the primary goals of the Indian River Lagoon SWIM Plan are as follows:

- "To attain and maintain water and sediment of sufficient quality … in order to support a healthy, macrophyte-based estuarine lagoon system."
- "To attain and maintain a functioning macrophyte-based ecosystem which supports endangered and threatened species, fisheries and wildlife."

Essentially, these Indian River Lagoon SWIM goals are consistent with the concept established in the State of Florida water quality standards for narrative nutrients (62-302.530 (48(b)) F.S.) which states that "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna." Thus, a healthy macrophyte-based aquatic ecosystem within the Indian River Lagoon would be a direct indication of full support of the Class III designated use of aquatic flora and fauna.

In order to achieve this goal of a healthy macrophyte-based ecosystem, the Indian River Lagoon SWIM Plan sets forth a series of Seagrass and Water Quality objectives designed to create in-lagoon water quality conditions conducive to such a healthy ecosystem. One of the water quality objectives is defined as "Decreas(ing) inputs of excessive loadings of nutrients from point and non-point sources." The cause and effect relationship between nutrient loads and seagrass health is established within the Indian River Lagoon SWIM Plan and is based upon the principle that increased nutrient loads lead to both direct and indirect causes of light attenuation that limit the ability of seagrass to thrive. One of the technically derived management tools established to achieve this water quality objective of decreasing nutrient inputs is defined as a Pollutant Load Reduction Goal (PLRG). PLRGs can be described as the recommended reduction of existing pollutant loads to a waterbody in order to be protective of the resource. Alternatively, PLRGs can be considered as a planning objective for placing existing and proposed discharges from point and nonpoint sources into perspective in a relative or watershed-wide sense. The establishment of PLRGs is a requirement of Florida's SWIM program, and the application of PLRGs to support the development of TMDLs is specifically addressed within the Florida Watershed Restoration Act (403.067 F.S.). Achieving the Indian River Lagoon SWIM total nitrogen and total phosphorus PLRGs for protection of seagrasses will in-effect achieve the restoration of water quality conditions within Indian River

Lagoon sufficient to support the designated use of Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife.

6. Water Quality Assessment

A water quality assessment was conducted to reviewing all pertinent water quality data for the Indian River Lagoon. The primary constituents that were reviewed are: dissolved oxygen, chlorophyll a, nitrogen and phosphorus data. Upon review of the available water quality, trends in water quality suggest that recent management practices have improved water quality. The implementation of this TMDL and PLRG will further improve water quality in Indian River Lagoon.

6.1. Water Quality Data

For this effort, readily available water quality data and information have been assembled to support an up-to-date assessment of the water quality conditions and designated use support of the impaired segments within the Indian River Lagoon. Water quality data from two water quality databases were secured from the FDEP and the SJRWMD. The FDEP database is a continually evolving water quality database used to support FDEP's Impaired Waters Rule Program. The version that was available for this assessment is commonly referred to as "IWR Run 8.2" and was provided to EPA by FDEP in the fall of 2002. The water quality database provided by SJRWMD is referred to as the "Indian River Lagoon database" and was also provided to EPA in early 2003. Efforts were made to solicit additional readily available water quality data from other agencies and entities that have collected data within the watershed. The databases used for this analysis were the most complete and current sources of relevant water quality data. Water quality data from SFWMD for the southern Indian River Lagoon segments were obtained through the FDEP IWR Run 8.2 database. These data are available for download from the Florida Environmental Data Extraction Tool (FEDET) at the following address: http://fedet.tetratech-ffx.com/fedet/index.jsp.

7. Linkage of WBIDs to Indian River Lagoon SWIM Segments

Water Body Identification (BIDs) are the basic unit of surface water quality data aggregation and assessment for the State of Florida's Section 305(b) Water Quality Assessment Report and Section 303(d) Impaired Waters Lists. Table 2 presents the specific WBIDs within the Indian River Lagoon that were originally identified as impaired waters for nutrients, chlorophyll a and dissolved oxygen on the 1998 Section 303d list and in the 1999 Consent Decree. While WBIDs are useful tools for initial data aggregation and assessment, they are not the most appropriate representation of a watershed to facilitate the development of a Total Maximum Daily Load. For the Indian River Lagoon SWIM Update the SJRWMD has developed a delineation of the Lagoon and its tributary drainage basins that serves as more useful representation and subdivision of the system for calculating loads from contributing watersheds.

Within the entire Indian River Lagoon system, there are 37 distinct lagoon segments that were delineated based on natural or constructed breakpoints and tributary drainages within the lagoon. With the exception of WBID 3163, impaired WBIDs in this TMDL fall within Banana River Lagoon and the North and Central Indian River Lagoon "sublagoons." Within the Banana River Lagoon and North and Central Indian River Lagoon there are 28 distinct segments. In some places these segments are aggregated into larger units that will be referred to as "Lagoon Segments". Loads for Lagoon Segments represent the total contribution of loads to that portion of the lagoon from that segment's entire contributing watershed. Figure 2 and Table 2 display the original impaired WBID units and their relationship to the SWIM waterbody delineations. This TMDL will present current and allowable pollutant loads for the Indian River Lagoon based on the SWIM delineation.

Table 2 Relationship of WBIDS and Indian River Lagoon Lagoon Segments

WBID Name	WBID	IRL Segment(s)	Body	Parameters for TMDL
BANANA R. AB 520 CSWY	3057B	BR3-5	ESTUARY	Nutrients, DO
BANANA R. BL MATHERS	3057A	BR3-5, BR7	ESTUARY	Nutrients, DO
CRANE CREEK	3085	IR12	STREAM	Nutrients, Chla
TURKEY CREEK	3098	IR12	ESTUARY	Chla, DO
CRANE CREEK	3085A	IR12	ESTUARY	Nutrients, Chla
INDIAN R. AB SEB INLET	2963A	IR12, 13A, 13B, 14	ESTUARY	Nutrients
NO. PRONG SEBASTION R	3128	IR14	STREAM	Nutrients, Chla, DO
C-54 CANAL	3135	IR14	ESTUARY	Nutrients, Chla, DO
FELSMERE CANAL	3136	IR14	STREAM	Nutrients, Chla, DO
SEBASTION R. AB IND R.	3129A	IR14	ESTUARY	Nutrients, Chla, DO
SOUTH INDIAN RIVER	5003D	IR15	ESTUARY	Nutrients, Chla, DO
SOUTH INDIAN RIVER	5003C	IR16-20	ESTUARY	Nutrients, Chla, DO
BELCHER CAN/TAYLOR CK	3163	IR22***	STREAM	Nutrients, Chla, DO
INDIAN R. AB 520 CSWY	2963D	IR6-7	ESTUARY	Nutrients, DO
EAU GALLIE RIVER	3082	IR9-11	ESTUARY	Nutrients, Chla
INDIAN R. AB MELB CSWY	2963B	IR9-11	ESTUARY	Nutrients, DO
INDIAN R. AB MELB CSWY	2963C	IR9-11	ESTUARY	Nutrients

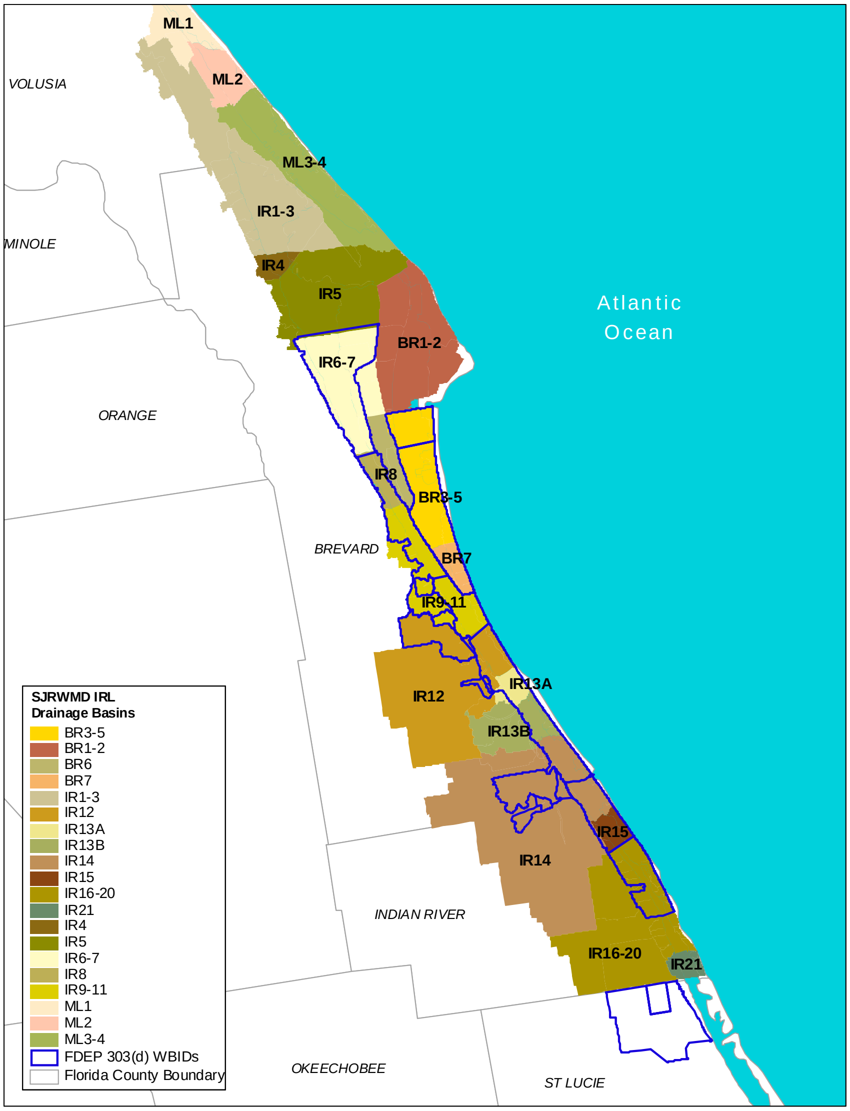

Figure 2 Relationship of WBIDs and SWIM Lagoon Segments

8. Source and Load Assessment

Nutrients enter surface waters from both point and nonpoint sources. Point sources are facilities that discharge at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. All point sources must have a National Pollutant Discharge Elimination System (NPDES) permit.

Point source contributions can typically be attributed to the following sources:

- Municipal wastewater facilities
- Municipal Separate Storm Sewers (MS4s)

Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters. Nonpoint sources can be attributed in a variety of ways. However, one common approach is to estimate or calculate nonpoint source loads based on land use type. In this analysis, nonpoint sources are broken out and loads are calculated by land use category using the Florida Land Use, Cover, and Forms Classification System (FLUCCS) scheme (Table 3). Land use categories can be broken into nine primary categories, and then more refined classifications are available at the FLUCCS Level 2 and Level 3.

Table 3 Nonpoint Source Land Use Categories from FLUCCS Level 1 Classification Scheme

Land Use Category	FLUCCS Code
Urban and Built Up	1000
Agriculture	2000
Rangeland	3000
Upland Forests	4000
Water	5000
Wetlands	6000
Barren Land	7000
Transportation, Communications and Utilities	8000

8.1. Point Sources

8.1.1. Permitted Point Sources

There are 9 active domestic wastewater treatment plants (WWTP) within the North and Central Indian River Lagoon and Banana River Lagoon drainage area (Figure 3 & Table 4). WWTP facilities are permitted through the National Pollutant Discharge Elimination System (NPDES) Program. WWTP facilities within the watershed receive human waste from the collection system and typically provide secondary levels of treatment prior to discharge which reduces nutrient loads to some extent. According to the Indian River Lagoon SWIM Update 2002, prior to 1995 point source discharges from WWTP to the Indian River Lagoon accounted for approximately 15% to 20% of the average annual external nutrient load to the lagoon. In some segments those contributions constituted up to 70% of the total annual external load. In light of this situation, the Indian River Lagoon Act was passed in 1990 and required most WWTP facilities to eliminate discharges to the Indian River Lagoon by 1995. Currently, 3 NPDES facilities discharge continuously to the Indian River Lagoon (New Smyrna Beach, Edgewater, and Canaveral WWTPs), while the other NPDES facilities may discharge to Indian River Lagoon intermittently during wet weather conditions. The SWIM Update estimates that point source discharges of total nitrogen and total phosphorus to Indian River Lagoon were reduced by more than 90% and 95% respectively between 1985 and 2000.

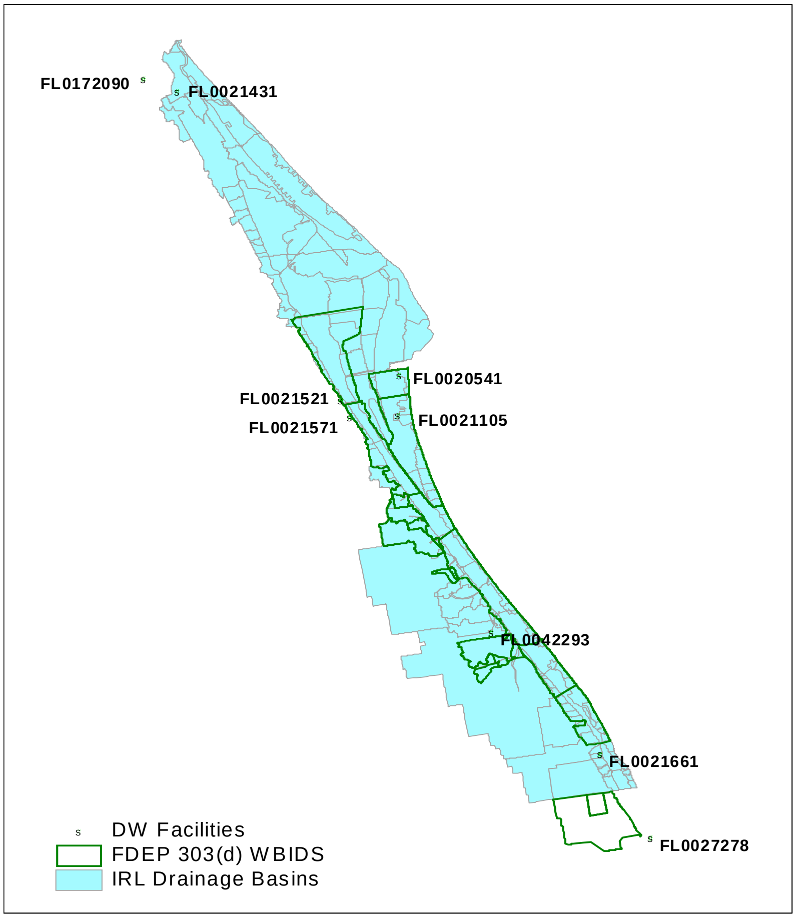

Figure 3 Point Source Discharger locations in Indian River Lagoon

Table 4 NPDES Permitted Facilities within N&C IRL and Banana River Lagoon

Facility Name	Facility ID	Permitted Discharge (mgd)	Permitted TN Concentrations (mg/l)	Permitted TP Concentrations (mg/l)
CAPE CANAVERAL	FL0020541	1.80	3.75	0.62
COCOA BEACH WTP	FL0021105	6.00	12.00	4.00
EDGEWATER STP,CITY OF	FL0021431	0.83	3.75	1.25
COCOA-WAT POLL CNTL FAC	FL0021521	4.50	12.00	4.00
ROCKLEDGE, CITY OF (DW)	FL0021571	Report Only	12.00	4.00
VERO BEACH WWTP-INDIAN RIVER	FL0021661	4.50	20.00	6.00
FORT PIERCE UTILITY AUTHORITY--WWTF	FL0027278	*	*	*
FL CITIES BAREFOOT BAY WWTP	FL0042293	0.75	3.75	1.25
NEW SMYRNA BEACH (DW)	FL0172090	*	*	*

Discharge and permit limit data from the FDEP WAFR database were obtained and reviewed in order to calculate average annual permitted loads of total nitrogen and total phosphorus from NPDES permitted facilities within the Indian River Lagoon. These permitted loads are incorporated in the wasteload allocation of the TMDL.

Data used in the calculation of point source waste loads was obtained from FDEP. For the domestic wastewater treatment facilities within the IRL, EPA was provided with the actual discharge data recorded for each facility from 1996 through 1999.

The following steps were undertaken;

- Data for discharge flow, Total Nitrogen and Total Phosphorus from the facilities discharging to the IRL were situated together.
- TN and TP values were provided in units of mg/l for each month. Each of these values was multiplied by the measured discharge flow, in MGD, and a conversion factor to give a monthly load in kg/day.
- These monthly values were then averaged together to yield an annual average load in kg/day for each year over the period of record.
- The annual average values were then multiplied by the number of days that the facility in question was allowed to discharge to receiving waters. In the case of Wet Weather discharge, this value was 91 days. For continuous discharge, which only took place at FL0020541, FL0021431 and FL0172090, a value of 365 days was used. This provided a load in units of kg.
- Using a conversion factor, the load for each year was converted to lbs. Then, all the annual loads for each year for a given facility were averaged together to give an overall annual average load in lbs for that facility.

Note the following:

For FL0042293 and FL0172090, no loads were calculated as TN and TP measurements are not a requirement of the permit

8.1.2. Municipal Separate Storm System Permits

Municipal Separate Storm water Systems (MS4s) are point sources also regulated by the NPDES program. Discharge from storm water pipes or conveyances potentially include urban runoff high in bacteria and other pollutants.

In 1990, EPA developed rules establishing Phase I of the National Pollutant Discharge Elimination System (NPDES) storm water program, designed to prevent harmful pollutants from being washed by storm water runoff into Municipal Separate Storm Sewer Systems (MS4s) (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of “medium” and “large” MS4s (those generally serving populations of 100,000 or greater) to implement a storm water management program as a means to control polluted discharges from MS4s. Approved storm water management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES storm water program to certain “small” MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Storm Water Program. Only a select subset of small MS4s, referred to as “regulated small MS4s”, require an NPDES storm water permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of a UA that are designated by NPDES permitting authorities.

For the purpose of this TMDLs MS4 outfalls will have to meet the percent reductions as prescribed for the nonpoint sources. Best management practices will need to be develop to achieve the reductions in nutrients and sediments as prescribed by the TMDL.

8.2. Nonpoint Sources

Nonpoint sources contribute a greater annual load of nutrients into the Indian River Lagoon than do point sources. Nonpoint sources represent contributions from diffuse sources, rather than from a defined outlet. On the land surface, nutrients accumulate over time from diverse sources such as dead plant matter, fertilizers, and atmospheric deposition. This accumulation of nutrients is washed from the land surface into the adjacent water body.

The land use distribution of the Indian River Lagoon watershed provides insight into determining nonpoint sources of nutrients. Figure 4 displays land use information by Lagoon Segment.

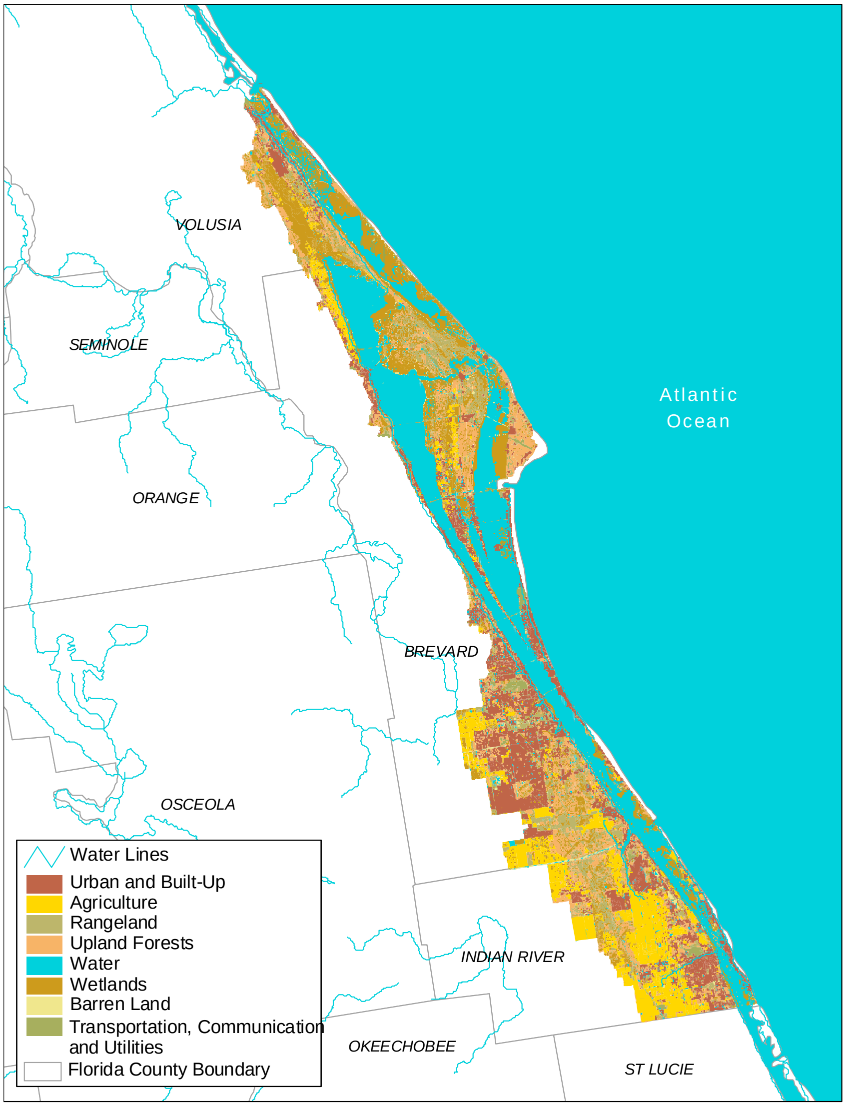

Figure 4 Land Uses within the Indian River Lagoon watershed

8.2.1. Urban and Built Up Lands

Urban and built up lands include uses such as residential, industrial, extractive and commercial. Land uses in this category in the IRL watershed have high total nitrogen event mean concentrations and average total phosphorus event mean concentrations. Urban and built land uses occur throughout the watershed, but are clustered along the shores of the lagoon and throughout segment IR 12.

8.2.2. Agriculture

Agricultural lands include improved and unimproved pasture, row and field crops, citrus, and specialty farms. The highest total nitrogen and total phosphorus event mean concentrations in the IRL watershed are associated with agricultural land uses. Within the Indian River Lagoon watershed agricultural land uses are found primarily in inland areas within Lagoon Segments IR12, IR14 and IR 16-20.

8.2.3. Rangeland

Rangeland includes herbaceous, scrub, disturbed scrub and coastal scrub areas. Rangeland occurs primarily in inland areas of IR14 and southward. Event mean concentrations for rangeland are about average for total nitrogen and low for total phosphorus.

8.2.4. Upland Forests

Upland Forests include flatwoods, oak, various types of hardwoods, conifers and tree plantations. Within the Indian River Lagoon watershed upland forests occur from IR12 southward in inland areas in large and small patches. Event mean concentrations for upland forests are low for both total nitrogen and total phosphorus.

8.2.5. Water and Wetlands

Open water and wetlands occur throughout the IRL watershed and have very low event mean concentrations down to zero. Open water occurs primarily along the eastern portion of the watershed in the lagoon, and in scattered undeveloped wetlands in the southwestern portion of the watershed.

8.2.6. Barren Land

Barren land includes beaches, borrow pits, disturbed lands and fill areas. Barren lands comprise only a small portion of the IRL watershed.

8.2.7. Transportation, Communications and Utilities

Transportation uses include airports, roads and railroads. Event mean concentrations in PLSM for these types of uses are in the mid range for total nitrogen and total phosphorus.

9. Modeling

Large watersheds with distinct subwatersheds, varied land uses and soil types, and numerous potential sources of pollutants require, at a minimum, a model or tool that allows one to consider the interaction of these factors in a spatially distributed context. These interactions have a significant influence on the total loads of the pollutants in question that are ultimately delivered to the lagoon. The modeling approach that was applied to simulate nutrient fate and transport in the Indian River Lagoon watershed is described in this section.

9.1. Model Selection

Selection of the appropriate analytical tool for TMDL development was based on an evaluation of technical and regulatory criteria. Key technical factors that were important in the selection process include the impacts of both point and non point source contributions from the watershed to IRL.

9.1.1. Point and nonpoint sources must be considered

The watershed is large (2284 sq miles) with spatially varied land uses and soil types that influence runoff volumes and loads. The factors that influence total nutrient loads delivered to the system have changed over time as land uses have been altered

Through other efforts, SJRWMD and SFWMD have already developed tools and a technical approach to address nutrient loads and continue to refine those tools while developing more sophisticated techniques as well. EPA Region 4 recognizes the significant effort that has gone into developing these ongoing efforts and recommends a technical approach for this TMDL that is consistent with the WMDs approach. Both SJRWMD and SFWMD are developing detailed hydrodynamic models that will be able to simulate the transport and fate of nutrients from the tributaries into the lagoon system and then simulate nutrient processes and cycling within the lagoon itself. These models however, are not ready for use to develop a TMDL. However, SJRWMD has developed and refined the Pollutant Load Screening Model (PLSM or "Plasm") which is a tool to help quantify nonpoint source loads associated with average annual runoff. PLSM has been used by SJRWMD to develop interim PLRG's for the Indian River Lagoon SWIM 2002 Update. These interim PLRGs are expressed as allowable average annual loads of total nitrogen and total phosphorus.

PLSM is a spatially distributed GIS-based stormwater model that can estimate the annual load of total nitrogen, total phosphorus, and total suspended solids delivered to Indian River Lagoon. Pollutant loads are expressed as average annual load per acre for each individual drainage basin. The total loads fort each basin are aggregated by Lagoon segment as necessary. Pollutant loads are generated from multiple spatially distributed inputs such as land use, soil types, hydrologic boundaries, runoff coefficients and event mean concentrations. By varying the land use coverage as desired, various estimates of current, future build-out and historic loads can be calculated.

9.2. Model Set Up

PLSM was originally developed to support planning level analyses for SJRWMD in 1995 and 1996. Since that time the model has been refined and improved for the Indian River Lagoon Watershed in support of the Indian River Lagoon SWIM Update 2002 and more recent efforts. Since the SWIM update, the model set-up has been slightly modified to generate more refined "allowable loads" as compared to the "current loads". These differences are noted where appropriate. PLSM is a spatially distributed GIS-based model that uses soil types, land uses and precipitation to generate loads per acre of total nitrogen, total phosphorus and TSS. Figure 5 displays the computational framework of PLSM (Mundy and Bergman, 1998).

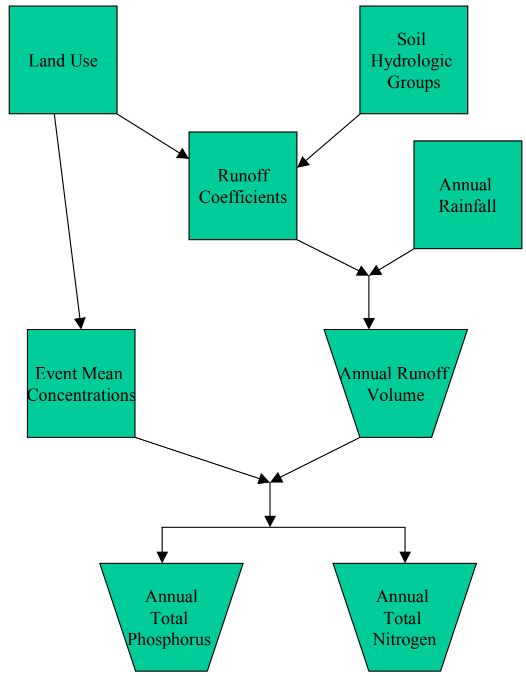

Figure 5 PLSM Computational Framework

9.2.1. Soils

The soil data layer is the Soil Survey Geographic Database (SSURGO) developed by the Natural Resource Conservation Service. Soils are classified based on their hydrologic group rating of A. B, C, D, B/D, C/D, and U. Group U soils were assigned the mean of the runoff coefficient for the four groups. B/D and C/D soils were assigned the D coefficient where lands are undeveloped and the B or C coefficient where developed.

9.2.2. Land Use

Land uses to calculate the current loads are based on the SJRWMD 1995 FLUCCS land uses coverages (cite). Land uses to calculate the allowable loadings are based on interpretation of historic aerial photographs of the watershed from 1943 (Larson, et al 1997). These land use maps were converted into GIS coverages for use in PLSM. Land use codes developed for this effort vary slightly from standard FLUCCS codes (Green, 2003), but the event mean concentrations have been indexed accordingly to address this issue.

9.2.3. Precipitation

Rainfall data were obtained from several National Oceanic and Atmospheric Administration rainfall stations distributed throughout the watershed. Theissen polygons were developed for each station and mean annual rainfall was calculated and weighted across the watershed. For current loads, the rainfall period of record was from 1960 to

1995 while the period of record for allowable loads was from approximately 1930 to 1954 (Green, personal communication, 2003).

9.2.4. Hydrologic Boundaries

For current loads, hydrologic boundaries were determined from USGS 7.5 minute quadrangle maps at 5 or 10 foot contour intervals. The hydrologic boundary delineation for current loads is represented in Figure 6. For allowable loads, these hydrologic boundaries were modified to include portions of the Melbourne Tillman Water Control District and headwaters of the Sebastian River that drained into the Indian River Lagoon in 1943

9.2.5. Runoff Coefficients

SJRWMD has defined runoff coefficients based on the combination of soil type and land uses within a minimum polygon size of .45 acres. Runoff coefficients are multiplied by annual rainfall to determine an annual runoff volume from a particular parcel. Table 5 displays the runoff coefficients that were used to generate the current loads based on 1995 land uses.

Table 6 displays the runoff coefficients that were used to generate the allowable loads based on 1943 land uses. These runoff coefficients are derived from numerous standard references and additional local studies and reflect a serious effort by SJRWMD to improve the PLSM model. Changes in runoff coefficients and event mean coefficients between the current and allowable scenarios are a product of ongoing efforts by SJRWMD to refine and improve the calibration of PLSM.

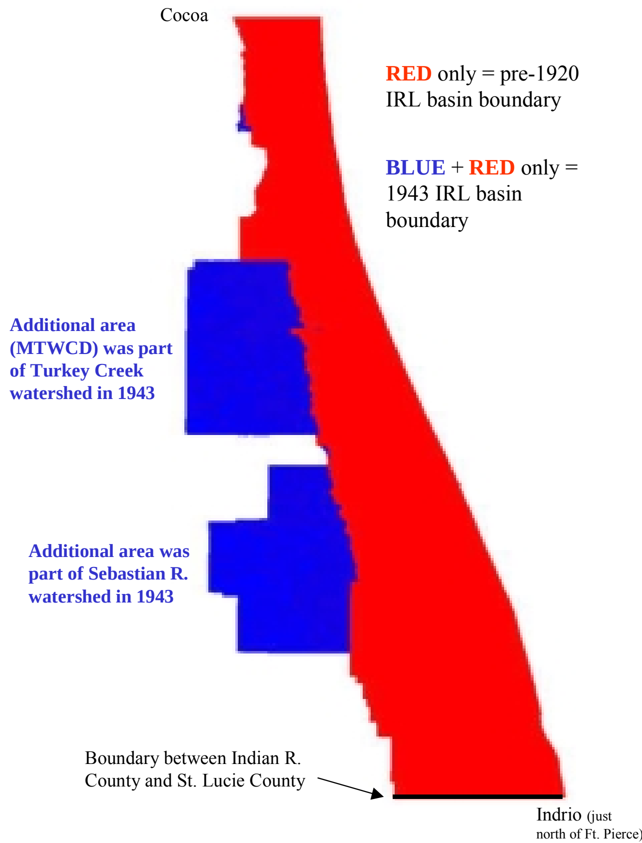

Figure 6 Hydrologic Boundary Modification for Allowable Loads

9.2.6. Event Mean Concentrations

Event mean concentrations are applied to the annual average runoff volume to calculate an average annual total nitrogen or total phosphorus load for that parcel. The event mean concentration reflects the average concentration of a parameter that would be found in surface water running off from a parcel of land with a consistent land use. The sum of all loads within a drainage basin is calculated to develop a total annual load of total nitrogen and total phosphorus and an average annual load per acre for a watershed. Table 7 displays the event mean concentrations for the current load scenario, while Table 8 provides the event mean concentrations of the allowable loads (1943 landuse distribution).

Table 5 PLSM Runoff Coefficients for Calculating Current (1995) Loads

1995 Land Use Code	Land Use	Runoff Coefficients A	B	C	D	B/D	C/D	U	Source
1100	Residnt_Low	0.174	0.230	0.286	0.342	0.342	0.342	0.286	Adamus/Bergman* 3
1101	Rural Residential	0.174	0.230	0.286	0.402	0.402	0.402	0.316	Malabar study
1190	RL under construct	0.160	0.181	0.202	0.223	0.223	0.223	0.191	Disturbed
1200	Residnt_Med	0.220	0.304	0.389	0.473	0.304	0.389	0.347	Adamus/Bergman
1290	RM under construct	0.160	0.181	0.202	0.223	0.223	0.223	0.191	Disturbed
1300	Residnt_High	0.631	0.662	0.692	0.723	0.662	0.692	0.677	Adamus/Bergman
1320	MH Parks	0.631	0.662	0.692	0.723	0.662	0.692	0.677	Adamus/Bergman
1390	RH under construct	0.160	0.181	0.202	0.223	0.223	0.223	0.191	Disturbed
1410, 1420, 1460, 1470	Commercial_high	0.886	0.887	0.888	0.900	0.887	0.888	0.890	Adamus/Bergman
1430 & 1480	Commercial_low	0.729	0.786	0.843	0.900	0.786	0.843	0.815	Adamus/Bergman
1490	Com under construct	0.160	0.181	0.202	0.223	0.223	0.223	0.191	Disturbed
1500 - 1562	Industial	0.760	0.793	0.825	0.858	0.793	0.825	0.809	Adamus/Bergman
1600 - 1650	Mining	0.220	0.304	0.389	0.473	0.304	0.389	0.347	Adamus/Bergman
1660	M-Reclaimed Lands	0.127	0.155	0.182	0.210	0.183	0.196	0.169	RO
1700 - 1790	Institution	0.680	0.724	0.768	0.836	0.724	0.768	0.752	Avg. of LC & HDR
1800, 1810, 1860	Rec_Open	0.127	0.155	0.182	0.210	0.183	0.196	0.169	Adamus/Bergman*
1820	Golf Course	0.182	0.222	0.258	0.298	0.222	0.258	0.240	Calculated Imperv1
1830	Race Track	0.630	0.703	0.777	0.850	0.703	0.777	0.740	Transportation
1840	Marinas	0.232	0.319	0.407	0.494	0.319	0.407	0.363	Calculated Imperv1
1850	Parks	0.126	0.212	0.300	0.387	0.212	0.300	0.256	Calculated Imperv1
1870	Stadiums	0.499	0.543	0.589	0.637	0.543	0.589	0.576	Calculated Imperv1
1900-1930	Open Land	0.151	0.193	0.234	0.276	0.193	0.234	0.213	Low Res & Open
2110	Improved Pasture	0.251	0.305	0.359	0.413	0.405	0.405	0.332	Adamus/Bergman
2120, 2130	Lowus_Ag (Pasture)	0.189	0.256	0.334	0.411	0.411	0.411	0.298	Adamus/Bergman
2140 - 2160	Crops	0.204	0.281	0.358	0.435	0.281	0.358	0.320	Harper 1994
2200 – 2220	Citrus	0.251	0.268	0.285	0.302	0.268	0.285	0.277	Harper 1994
2240	Abandoned Grove	0.251	0.268	0.285	0.302	0.268	0.285	0.277	Citrus
2310 & 2320	Feed Lots	0.157	0.190	0.224	0.251	0.190	0.224	0.207	ECFRPC - Calculated Imperv1
2410 – 2430 & 2460	Nurseries	0.251	0.268	0.285	0.302	0.268	0.285	0.277	Citrus
2510	Stables	0.205	0.260	0.315	0.370	0.260	0.315	0.288	(Calculated % impervious)
2520	Dairies	0.506	0.549	0.592	0.636	0.549	0.592	0.571	Pasture/Ind
2610	Fallow Crop	0.204	0.281	0.358	0.435	0.281	0.358	0.320	Crops-Harper
3100	Rangeland Herb	0.100	0.195	0.300	0.411	0.411	0.411	0.252	From CNs - see Range C
3200 &3300	Range Shrub/Mixed	0.060	0.176	0.287	0.400	0.400	0.400	0.231	From CNs - see Range C
4000 – 4370	Forests	0.102	0.206	0.309	0.413	0.413	0.413	0.258	Hedrickson 2000
4400 – 4900	Silviculture	0.102	0.206	0.309	0.413	0.413	0.413	0.258	Hedrickson 2000
5000 – 5190	Watercourses	1.000	1.000	1.000	1.000	1.000	1.000	1.000	Harper 1994
5200 – 5340	Lakes_Reservoirs	0.500	0.500	0.500	0.500	0.500	0.500	0.500	Harper 1994

5400	Estuary	1.000	1.000	1.000	1.000	1.000	1.000	1.000	Consensus
5690	Sloughs	0.191	0.228	0.266	0.303	0.303	0.303	0.247	Same as Wetland
6000 – 6300	Forest Wetlands	0.191	0.228	0.266	0.303	0.303	0.303	0.247	Harper Wetland
6400 – 6490	Herb/shrub Wetlands	0.191	0.228	0.266	0.303	0.303	0.303	0.247	Harper Wetland
6510 & 6520	Unveg'd Wetland	0.191	0.228	0.266	0.303	0.303	0.303	0.247	Harper Wetland
7000 – 7340	Beaches-Barren	0.102	0.206	0.309	0.413	0.413	0.413	0.258	Hedrickson 2000
7400	Disturbed	0.160	0.181	0.202	0.223	0.223	0.223	0.191	Avg. of subcategories
7410	Rural Transition	0.151	0.193	0.234	0.276	0.234	0.234	0.255	Avg. LDR/RO*
7420 – 7430	Borrow-Spoil	0.169	0.169	0.169	0.169	0.169	0.169	0.169	Constant 0.1692
8140 & 8150	Transportation	0.630	0.703	0.777	0.850	0.703	0.777	0.740	Harper 1994
8110	Airports	0.630	0.703	0.777	0.850	0.703	0.777	0.740	Transptn - Harper 1994
8120	Railroads	0.200	0.250	0.300	0.350	0.250	0.300	0.275	Wanielista,Yousef 1981
8160	Canals Navigable	1.000	1.000	1.000	1.000	1.000	1.000	1.000	Harper 1994
8130, 8180	Highload Transp	0.886	0.887	0.888	0.900	0.887	0.887	0.890	HC
8210 & 8220	Communications	0.127	0.155	0.182	0.210	0.155	0.182	0.169	RO
8310	Power Plants	0.760	0.793	0.825	0.858	0.793	0.825	0.809	Industrial
8320	Powerlines	0.127	0.155	0.182	0.210	0.210	0.210	0.169	RO
8330 & 8340	Water/Sewer Plants	0.174	0.230	0.286	0.342	0.230	0.286	0.258	LDR
8350	Landfill	0.252	0.329	0.407	0.485	0.329	0.407	0.368	(10%Trans/20%LDR/70%Min)
8390	Utility Construction	0.160	0.181	0.202	0.223	0.181	0.202	0.191	Disturbed

Table 6 PLSM Runoff Coefficients Changed for Allowable Loads Scenario

Land Use Code	Land Use	Runoff Coefficient by Soil Hydrologic Group								
Soil Hydrologic Group		A	B	C	D	B/D	C/D	U	W	X
2110	Improved Pasture					.405	.405			.250
2120	Unimproved Pasture		.256	.334	.411	.411	.411	.283	.283	
2150	Field Crops		.256	.334	.411	.411	.411	.283	.283	.320

Table 7 PLSM Event Mean Concentrations for Current Loads Scenario

1995 Land Use Code	Land Use	Nutrient Concentrations mg/l	
		TN	TP
1100	Residnt_Low	1.85	0.220
1101	Rural Residential	1.05	0.220
1190	RL construction	1.38	0.080
1200	Residnt_Med	2.39	0.300
1290	RM construction	1.38	0.080
1300	Residnt_High	2.42	0.490
1320	MH Parks	2.42	0.520
1390	RH construction	1.38	0.080
1410, 1420, 1460, 1470	Commercial high	2.83	0.430
1430 & 1480	Commercial low	1.58	0.180
1490	Commer construct	1.38	0.080
1500 - 1562	Industrial	1.79	0.310
1600 - 1650	Mining	1.18	0.150
1660	M-Reclaimed Lands	1.25	0.076
1700 - 1790	Institution	1.80	0.320
1800,1810,1860,1900-30	Rec_Open	1.25	0.076
1820	Golf Course	1.78	0.296
1830	Race Track	2.08	0.340
1840	Marinas	1.58	0.150
1850	Parks	1.25	0.076
1870	Stadiums	2.04	0.242
2110	Improved Pasture	2.70	0.576
2120, 2130	Lowuse_Ag (Pasture)	2.52	0.080
2150	Field Crops	2.52	0.265
2140 & 2160	Row Crops	4.56	1.000
2200 – 2230	Citrus	1.92	0.506
2240	Abandoned Grove	1.59	0.250
2310 & 2320	Feed Lots	3.74	1.130
2410 – 2430 & 2460	Nurseries	2.30	0.565
2510	Stables	2.32	0.500
2520	Dairies	2.82	0.715
2540	Aquaculture	1.87	0.265
2600 & 2610	Fallow Crop	2.91	0.547
3100	Rangeland Herb	1.25	0.064
3200 &3300	Range Shrub/Mixed	1.25	0.064
4000 – 4370	Forests	0.70	0.088
4400 – 4900	Silviculture	0.70	0.088
5000 – 5190	Watercourses	0.60	0.050
5200 – 5340	Lakes_Reservoirs	0.60	0.110
5400	Estuary	0.00	0.000
5690	Sloughs	0.00	0.000
6000 – 6300	Forest Wetlands	0.00	0.000
6400 – 6490	Herb/shrub Wetlands	0.00	0.000
6500, 6510 & 6520	Unveg'd Wetland	0.00	0.000
7000 – 7340	Beaches-Barren	1.25	0.053
7400	Disturbed	1.38	0.109
7410	Rural Transition	1.51	0.115
7420 – 7430	Borrow-Spoil	1.25	0.102
7440	Causeway fill	1.25	0.076

8100	Transportation	1.58	0.470
8140	4-Lane divided Hwy	2.08	0.470
8110	Airports	2.08	0.150
8120	Railroads	1.25	0.053
8150	Port Facilities	2.83	0.430
8160	Canals Navigable	0.60	0.077
8130, 8180	Highload Transp	2.83	0.430
8210 & 8220	Communications	1.25	0.076
8310	Power Plants	1.79	0.310
8320	Powerlines	1.25	0.076
8330 & 8340	Water/Sewer Plants	1.77	0.177
8350	Landfill	1.39	0.177
8390	Utility Construction	1.38	0.109

Table 8 Event Mean Concentration for Allowable Loads (1943) Scenario

Landuse Code	1943 Land Use	Total N mg/l	Total P mg/l	Landuse Code	1943 Land Use	Total N mg/l	Total P mg/l
1110	Low Residential	1.85	0.217	4214	Disturbed Oak	0.70	0.088
1120	Med Residential	2.39	0.300	4220	Brazilian Pepper	0.70	0.088
1130	High Residential	2.42	0.490	4230	Oak-Hickory-Pine	0.70	0.088
1150	Industrial	1.79	0.310	4250	Hardwood	0.70	0.088
1160	Extractive	1.18	0.150	4270	Live Oak	0.70	0.088
1180	Rec-Open Space	1.25	0.076	4280	Cabbage Palm	0.70	0.088
1401	Low Commercial	1.58	0.180	4340	Conifer - Hardwood	0.70	0.088
1410	High Commercial	2.83	0.430	4350	Dead Trees	0.70	0.088
1800	Transportation	1.58	0.150	4370	Austalian Pine	0.70	0.088
1811	Airports	1.58	0.150	4380	Mixed Hardwood	0.70	0.088
1812	Railroads	1.25	0.076	4400	Tree Plantations	0.70	0.088
1814	Roads/Highways	1.18	0.470	5000	Ocean	0.00	0.000
2110	Improved Pasture	2.82	0.576	5100	Streams & Waterways	0.60	0.050
2120	Unimpr Pasture	2.52	0.080	5210	Lakes	0.60	0.110
2140	Row Crops	4.56	1.000	5240	Lakes	0.60	0.110
2150	Field Crops	2.52	0.265	5250	Open water marsh	0.00	0.000
2200	Citrus	1.92	0.506	5330	Reservoirs	0.60	0.110
2210	Citrus	1.92	0.506	5340	Reservoirs	0.60	0.110
2211	Citrus Mature	1.92	0.506	5420	Embayment/Lagoon	0.00	0.000
2212	Citrus New	1.92	0.506	5430	Salt water ponds	0.00	0.000
2240	Abandoned Grove	1.59	0.250	5530	Reservoirs	0.60	0.110
2300	Specialty Farms	2.57	0.608	6120	Forested wetland	0.00	0.000
2500	Misc Ag	2.32	0.500	6150	Forested wetland	0.00	0.000
3100	Herb Rangeland	1.25	0.064	6160	Sloughs	0.60	0.000
3200	Scrub and Brush	1.25	0.064	6170	Forested wetland	0.00	0.000
3210	Palmettos	1.25	0.064	6180	Forested wetland	0.00	0.000
3220	Coastal Scrub	1.25	0.064	6210	Forested wetland	0.00	0.000
3221	Coastal Scrub	1.25	0.064	6230	Forested wetland	0.00	0.000
3222	Coastal Scrub	1.25	0.064	6250	Scrub Wetlands	0.00	0.000
3223	Disturbed Scrub	1.25	0.064	6300	Forested wetland	0.00	0.000
3230	Coastal Dune	1.25	0.064	6410	Marsh wetland	0.00	0.000
3290	Disturbed Scrub	1.25	0.064	6411	Marsh wetland	0.00	0.000
3300	Mixed Rangeland	1.25	0.064	6420	Marsh wetland	0.00	0.000
4000	Upland Forest	0.70	0.088	6430	Wet Prairie	0.00	0.000
4110	Flatwoods	0.70	0.088	6431	Wet Prairie	0.00	0.000
4111	Flatwoods-Savannah	0.70	0.088	6440	Marsh wetland	0.00	0.000

4112	Flatwoods	0.70	0.088	6460	Scrub wetland	0.00	0.000
4113	Flatwoods	0.70	0.088	6470	Scrub wetland	0.00	0.000
4120	Flatwoods	0.70	0.088	6510	Tidal Flat	0.00	0.000
4121	Flatwoods Scrub	0.70	0.088	6520	Shoreline	0.00	0.000
4122	Flatwoods	0.70	0.088	7100	Beaches	1.25	0.053
4123	Flatwoods	0.70	0.088	7200	Barren Land	1.25	0.053
4130	Sand Pine	0.70	0.088	7400	Disturbed Lands	1.38	0.109
4210	Xeric Oak	0.70	0.088	7410	Rural land in transition	1.51	0.115
4211	Oak	0.70	0.088	7420	Borrow Areas	1.25	0.102
4212	Oak	0.70	0.088	7430	Spoil & Dikes	1.25	0.102
4213	Disturbed Oak	0.70	0.088	7440	Fill areas (highways)	1.25	0.076

9.3. Model Calibration

The PLSM model was recently calibrated by SJRWMD for several sub-basins within the Indian River Lagoon watershed against measured pollutant loads and was compared to three commonly applied screening level watershed water quality models to determine its usefulness in establishing PLRGs and assisting in water quality planning efforts (Green and Steward, 2002). PLSM calculations of average annual flow and loads for total nitrogen, total phosphorus and total suspended solids were compared to measured flow and loads in the Crane Creek, C-1 Canal of Turkey Creek, South Prong of Sebastian River, and Briar Creek sub-basins. These basins were selected because they represent the variety of land uses within the Indian River Lagoon watershed and each basin has other screening level water quality models applied and calibrated for that basin.

When PLSM annual flow and load calculations were compared to measured annual loads for the four sub-basins, PLSM under predicted flow, slightly over predicted total nitrogen and total phosphorus, and over predicted total suspended solids load (Figure 7).

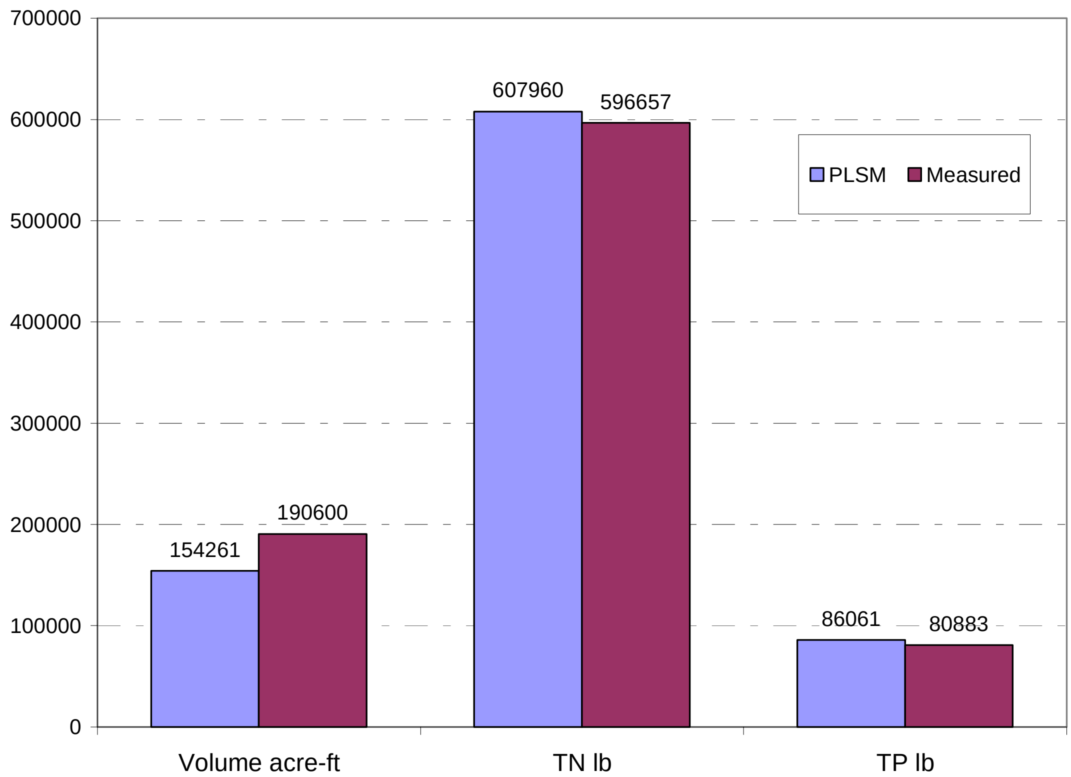

Figure 7 PLSM Estimated versus Measured Loads for Four Basins in IRL (Green and Steward, 2002)

PLSM was also compared to three calibrated watershed models in the four sub-basins: 1) HSPF (Donigian et al, 1984), 2) CALSIM (Pandit and Gopalakrishnan, 1997), and 3) LOADSIM (Pandit and Swain, 1992). PLSM flows and loads corresponded very closely to the calculated values from those three models as well. As Figure 8 shows, flows and total nitrogen loads had very close correspondence, while PLSM estimated total phosphorus loads were approximately 19% higher and total nitrogen were 4% lower.

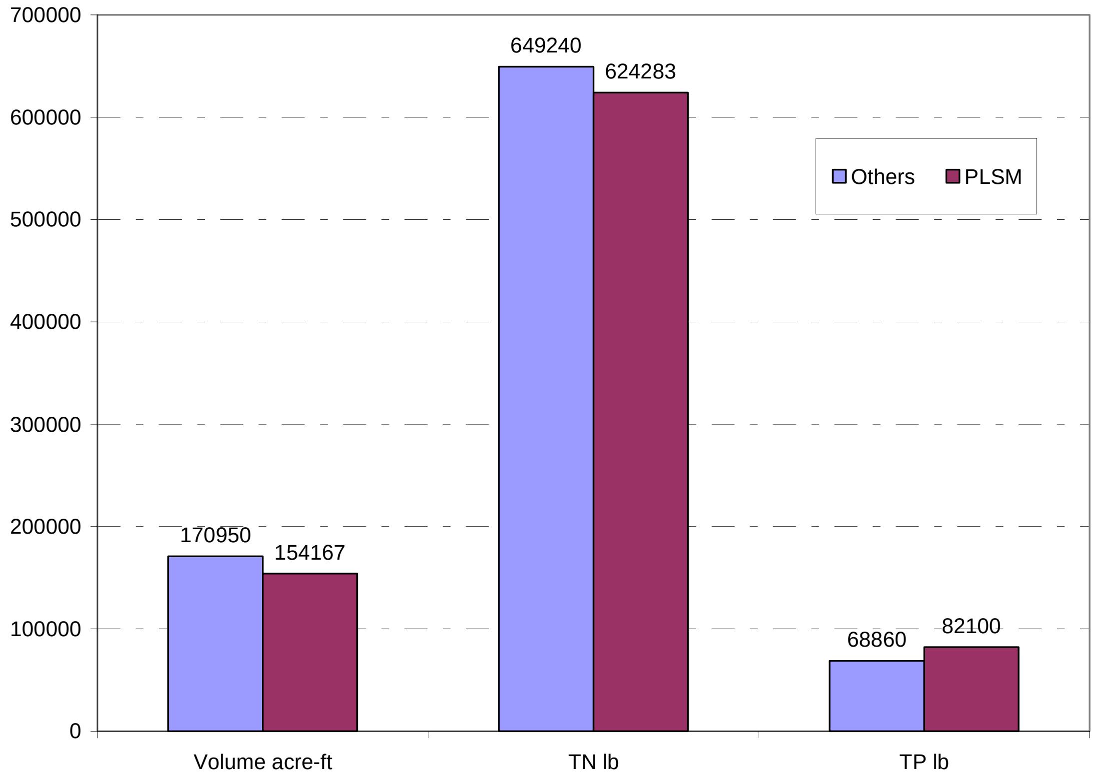

Figure 8 PLSM Estimated Flows and Loads versus Three Calibrated Watershed Models (Green and Steward, 2002)

As discussed in the model set up section, SJRWMD measured and applied improved event mean concentration runoff values for various land uses within the watershed. SJRWMD has also reviewed the existing FLUCCS 1995 land use coverage and has refined that coverage where local knowledge allows for improved delineations. Adjustments have also been made to the runoff coefficients to account for unusually dry or wet years. Finally, stormwater treatment efficiencies of 30% for total nitrogen, 50% for total phosphorus, and 70% for TSS were applied to newer developments post 1989 to simulate implementation of state stormwater regulations requiring wet detention.

9.4. Modeling Results

9.4.1. Point Sources

Available discharge data and permit limit information was used to calculate permitted annual loads of total nitrogen and total phosphorus coming from NPDES dischargers within the Indian River Lagoon watershed (Table 9). The total calculated annual loads of total nitrogen and total phosphorus from point sources are significantly smaller than the estimated total average annual nonpoint source loads within the Indian River Lagoon.

Table 9 Permitted Annual TN and TP Loads from WWTP within IRL watershed

Facility ID	Facility Name	Average Annual Flow	Permitted TN Load	Permitted TP Load
FL0020541	CAPE CANAVERAL (DW)	3.98	5874	427
FL0021105	COCOA BEACH, WRF	3.16	8931	2422
FL0021431	EDGEWATER, CITY OF (DW)	3.30	5330	733
FL0021521	COCOA/JERRY SELLERS (DW)	1.05	1560	73
FL0021571	ROCKLEDGE, CITY OF (DW)	0.35	25	27
FL0021661	VERO BEACH, CITY OF (DW)	9.61	28786	3448
FL0027278	FORT PIERCE UTILITY AUTHORITY--WWTF	3.00	3774	320
FL0042293	BAREFOOT BAY (DW)	1.30	---	---
FL0172090	NEW SMYRNA BEACH (DW)	13.29	83034	8816
Annual Totals		39.04	137314	16267

Note: FL0042293 does not have any WLAs assigned, as it is not subject to permit limitations for TN and TP.

9.4.2. Nonpoint Sources

A review of estimated loads from PLSM indicates that absolute total nitrogen and total phosphorus loads and loading rates per acre are highly variable throughout the Indian River Lagoon watershed (Table 10, Figure 9, Figure 10). In general, Banana River Lagoon Segments appear to have some of the highest per acre loading rates of total nitrogen and total phosphorus. These segments are highly developed residential and commercial areas. Northern Indian River Lagoon Segment 1-3 appears to have the lowest per acre loading rates of total nitrogen and total phosphorus. Not surprisingly, this area contains a large proportion of open water and undeveloped lands. In terms of total average annual loads (Table 10), Indian River Lagoon Segments 12, 14, and 16-20 contribute the greatest nutrient loads, but they are also some of the largest watersheds with the highest discharges to the lagoon. The segments with the highest nutrient loads per acre are IR 8, IR 9-11, IR 16-20, BR 3-5, BR 6, and 3163.

Table 10 PLSM Estimated Current (1995) Average Annual TN and TP (lbs) Nonpoint Loads by Lagoon Segment (Green, 2003)

Lagoon Segment	Area (acres)	Annual TN Load	TN Load per acre	Annual TP Load	TP Load per acre
IR 1-3	53628	138329	2.58	19889	0.37
IR 4	2638	17755	6.74	2590	0.98
IR 5	35323	134572	3.81	16725	0.47
IR 6-7	22003	107576	4.89	17349	0.79
IR 8	2743	21954	8.00	3085	1.12
IR 9-11	19894	157030	7.89	22572	1.13
IR 12	76034	518770	6.82	69469	0.91
IR 13A	1820	7919	4.35	981	0.54
IR 13B	16825	64767	3.85	7275	0.43
IR 14	117196	695736	5.94	114744	0.98
IR15	3545	19547	5.51	3477	0.98
IR16-20	66031	519788	7.87	91894	1.39
IR 21	2430	13636	5.61	2019	0.83
BR 1-2	33261	127997	3.85	15954	0.48
BR 3-5	7579	67742	8.94	9683	1.28
BR 6	6289	47576	7.56	6707	1.07
BR 7	4393	43799	9.97	6309	1.44
3163	24904	219823	8.83	42535	1.71
Totals	496536	2924316	5.89	453257	0.91

Figure 9 shows the estimate of annual total nitrogen and total phosphorus loads to Indian River lagoon by lagoon segments.

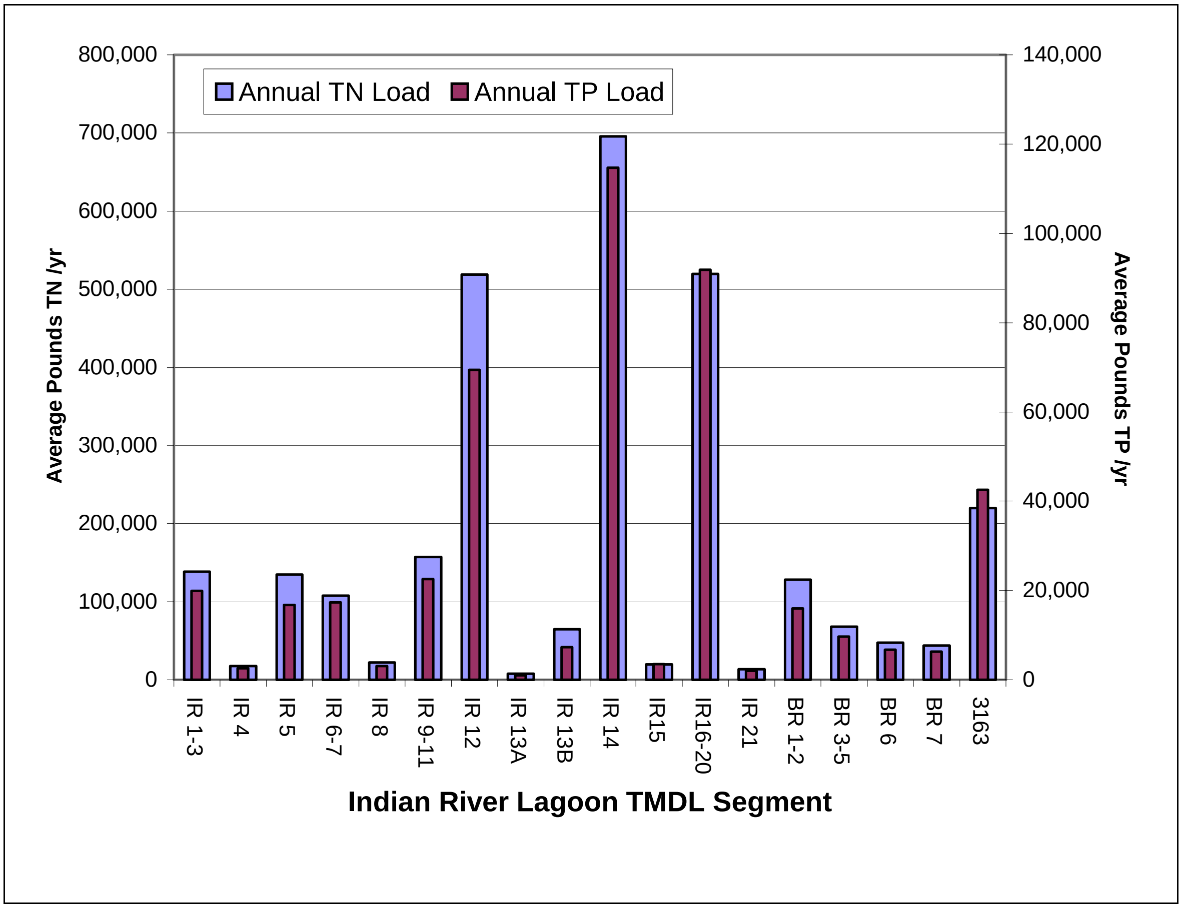

Figure 9 Estimated Annual Total Average Annual Loads of TN and TP by Lagoon Segment

Figure 10 shows the estimate of total nitrogen and total phosphorus loads per acre to Indian River lagoon by lagoon segments.

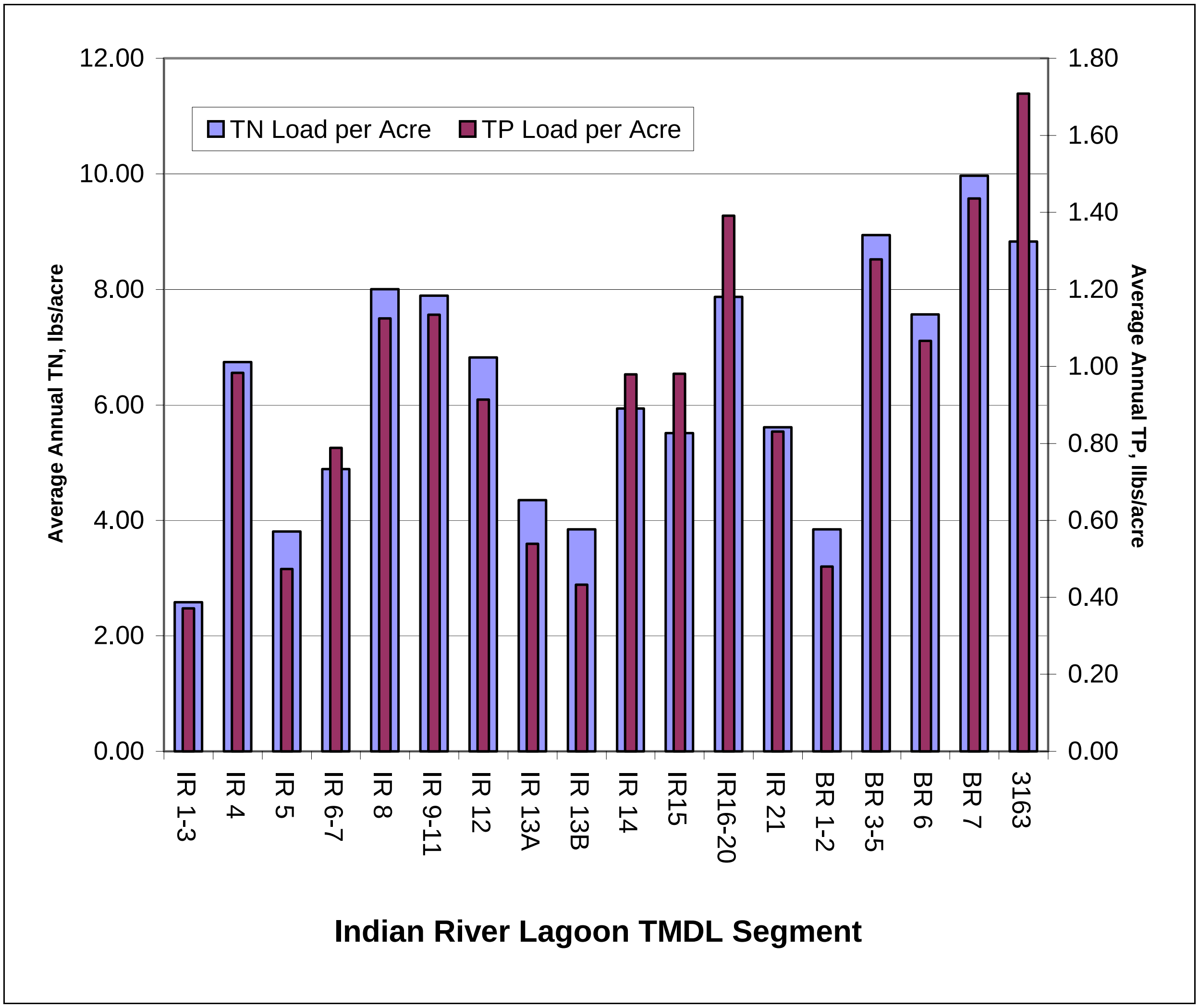

Figure 10 Estimated Average Annual Load per acre by Lagoon Segment

10. TMDL

A total maximum daily load (TMDL) for a given pollutant and waterbody is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards. A portion of the TMDL allocated to each of the pollutant sources as WLA for point source and LA for non point source. The allocations for all pollutant sources are identified that cumulatively provide for the basis for the State or WMD to prescribe controls that will ultimately achieve water quality standards. For nutrients, TMDLs can be expressed on a mass loading basis (e.g., pounds per day or year).

10.1. Critical Conditions

EPA regulations at 40 CFR 130.7(c)(1) requires TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition for the Indian River Lagoon is an average annual time step that takes into account wet season discharges from NPDES permitted dischargers and captures wet season stormwater runoff to the Indian River Lagoon. Current loads to the Indian River Lagoon watershed were determined based on 1995 land uses which is close to the time when the WBIDs were originally listed. Average annual loads provide a useful indication of the overall nutrient load being contributed to the Indian River Lagoon watershed that sets off a chain of events leading to light attenuation and diminished seagrass health and distribution.

10.2. Margin of Safety

There are two methods for incorporating the MOS (USEPA, 1991):

- Implicitly incorporate the MOS using conservative model assumptions to develop allocations
- Explicitly specify a portion of the total TMDL as the MOS and use the remainder for Allocations

For the Indian River Lagoon TMDLs, an implicit margin of safety was applied. An implicit MOS was incorporated the following ways:

- The allowable average annual loads of total nitrogen and total phosphorus were calculated based on land uses occurring within the watershed in 1943 when human alteration of the watershed was fairly minimal.
- Seagrass coverage in 1943 was at its greatest documented extent. Endeavoring to achieve water quality conditions sufficient to restore seagrass to their maximum known extent is a conservative assumption.
- Conservative assumptions were employed in developing the TMDL. NPDES permitted facilities were represented in the model using maximum permitted discharges.

10.3. Seasonal Variability

Seasonality is incorporated in this TMDL through the use of annual average loads. This approach includes both the influences of wet and dry weather conditions on loadings to the waterbody. Furthermore, the use of multi-year analysis in the development of current loadings incorporates a range of wet and dry years.

10.4. Load Allocation

Based on an interpretation of the model results and water quality standards, the TMDLs and their components (WLA, LA, and MOS) were derived. The TMDLs are presented below for total nitrogen and total phosphorus and are calculated to achieve the narrative nutrient criteria. Achieving the narrative nutrient criteria will also result in achieving appropriate dissolved oxygen and chlorophyll regimes as these impairments are a direct result of symptoms associated with cultural eutrophication caused by nutrient enrichment. The TMDLs are presented as cumulative values for total nitrogen and total phosphorus for that portion of Indian River Lagoon extending from North Indian River Lagoon and Banana River Lagoon to the southern end of the Central Indian River Lagoon and captures all but one of the impaired segments from the 1998 Consent Decree (WBID 3163). Achieving the load allocations within the lagoon segments should lead to water quality restoration within the individual segments and for the Lagoon as a greater whole.

$$\text{Nitrogen TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

TMDL = 137,314 lbs/year Total Nitrogen + 2,175,218 lbs/yr Total Nitrogen + implicit MOS

Total Nitrogen TMDL = 2,312,532 lbs/year Total Nitrogen (Point Source + Nonpoint Source)

$$\text{Phosphorus TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

TMDL = 16,267 lbs/year Total Phosphorus + 263,248 lbs/yr Total Phosphorus + implicit MOS

Total Phosphorus TMDL = 279,515 lbs/year Total Phosphorus (Point Source + Nonpoint Source)

10.5. Wasteload Allocations

10.5.1.NPDES Dischargers

Table 11 presents the sum of the NPDES permitted facilities and their allocated total nitrogen and total phosphorus loading. This allocation is based on the calculated average annual discharge times the maximum permitted total nitrogen and total phosphorus concentrations for the NPDES permitted facilities.

Table 11 Waste load allocations (WLAs) for NPDES permitted facilities in IRL watershed

NPDES Permit	Facility Name	Subwatershed	Average Annual TN Load (pounds)	Average Annual TP Load (pounds)
FL0020541	*CAPE CANAVERAL (DW)*	*BR 3-5*	*5874*	*427*
FL0021105	*COCOA BEACH, WRF*	*BR 3-5*	*8931*	*2422*
FL0021431	*EDGEWATER, CITY OF (DW)*	*IR 1-3**	*5330*	*733*
FL0021521	*COCOA/JERRY SELLERS (DW)*	*IR 6-7*	*1560*	*73*
FL0021571	*ROCKLEDGE, CITY OF (DW)*	*IR 8**	*25*	*27*
FL0021661	*VERO BEACH, CITY OF (DW)*	*IR 16-20*	*28786*	*3448*
FL0027278	*FORT PIERCE UTILITY AUTHORITY--WWTF*	*3163**	*3774*	*320*
FL0042293	*BAREFOOT BAY (DW)*	*IR 14*	*---*	*---*
FL0172090	*NEW SMYRNA BEACH (DW)*	*IR 1-3**	*83034*	*8816*
Totals			*137314*	*16267*

* - Subwatershed assignment denoted with an asterisk indicates that though the facility does not discharge directly to that segment, it has been linked to that subwatershed due to its relative proximity, and for the purposes of this report.

10.5.2. Municipal Separate Storm System Permits

The MS4 waste load allocation is expressed as a percent reduction that is equivalent with the load allocation. The MS4 Phase I service areas included in this TMDL are: Brevard County, Volusia County, Indian River County, St Lucie, and Orange County. Best management practices for the MS4 service area should be developed to meet the percent reduction for both nitrogen and phosphorus as prescribed in Table 12.

10.6. Load Allocations

Load allocations were made by Lagoon Segments (Table 12). Allocating by lagoon segment allows local and regional governments to work cooperatively to devise the most cost effective sub-basin specific load reduction plans that achieve maximum load reductions for the least amount of money. Also, because lagoon segments and their drainage basins represent the actual contributing drainage area for that portion of the lagoon, achieving the allowable load targets in those segments should lead to direct improvement in the water quality of that segment.

Table 12 Load Allocations for Lagoon Segments

Lagoon Segment	Area (acres)	Allocated Annual TN Load (pounds)	Allocated TN Load per acre (pounds)	% TN Load Reduction	Allocated Annual TP Load (pounds)	Allocated TP Load per acre (pounds)	% TP Load Reduction
IR 1-3	*53628*	*107925*	*2.01*	*22*	*18932*	*0.35*	*5*
IR 4	*2638*	*9356*	*3.55*	*47*	*2070*	*0.78*	*20*
IR 5	*35323*	*87470*	*2.48*	*35*	*9966*	*0.28*	*40*
IR 6-7	*22003*	*67735*	*3.08*	*37*	*12230*	*0.56*	*30*
IR 8	*2743*	*13143*	*4.79*	*40*	*2860*	*1.04*	*7*
IR 9-11	*19894*	*64697*	*3.25*	*59*	*7652*	*0.38*	*66*
IR 12	*76034*	*439505*	*5.78*	*15*	*41135*	*0.54*	*41*
IR 13A	*1820*	*7899*	*4.34*	*0*	*846*	*0.46*	*14*
IR 13B	*16825*	*65818*	*3.91*	*0*	*6734*	*0.40*	*7*
IR 14	*117196*	*715898*	*6.11*	*0*	*73692*	*0.63*	*36*
IR15	*3545*	*16739*	*4.72*	*14*	*3092*	*0.87*	*11*
IR16-20	*66031*	*312935*	*4.74*	*40*	*46314*	*0.70*	*50*
IR 21	*2430*	*5342*	*2.20*	*61*	*876*	*0.36*	*57*
BR 1-2	*33261*	*81767*	*2.46*	*36*	*7995*	*0.24*	*50*
BR 3-5	*7579*	*20798*	*2.74*	*69*	*2380*	*0.31*	*75*
BR 6	*6289*	*10708*	*1.70*	*77*	*1697*	*0.27*	*75*
BR 7	*4393*	*10094*	*2.30*	*77*	*1147*	*0.26*	*82*
3163	*24904*	*137389*	*5.52*	*38*	*23630*	*0.95*	*44*
Totals	*530641*	*2175218*	*4.10*		*263248*	*0.50*	

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